Design Issues in Farmer-Managed Irrigation Systems

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Proceedings of an International Workshop of the Farmer-Managed Irrigation Systems Network

Organized by
The International Irrigation Management Institute
and
The Thailand Research on Irrigation Management Network
and held at
Chiang Mai, Thailand
from 12 to 15 December 1989

Robert Yoder and Juanita Thurston, editors

November, 1990

INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE

Colombo, Sri Lanka

Towards Farmer-Managed Irrigation Water Distribution Systems in Nigeria

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INTRODUCTION

ABOUT 101,600 HECTARES (ha) in Nigeria are under modern medium-scale and large-scale irrigation (Maurya and Sachan 1984). This accounts for around 20 percent of the total land in West Africa under modern irrigation (Figure 1). Of the total irrigated area in Nigeria more than 80 percent is under surface irrigation. Large-scale irrigation systems in Nigeria consist mainly of big dams and reservoirs and their associated canal networks along with necessary infrastructure for large-scale irrigated cropping systems. Three large irrigation projects, the Kano River Irrigation Project (16,600 ha), the Bakolori Irrigation Project (23,300 ha), and the South Chad Irrigation Project (12,000 ha) cover a total of 51,900 ha made up of small holdings of 0.5-6 ha each.

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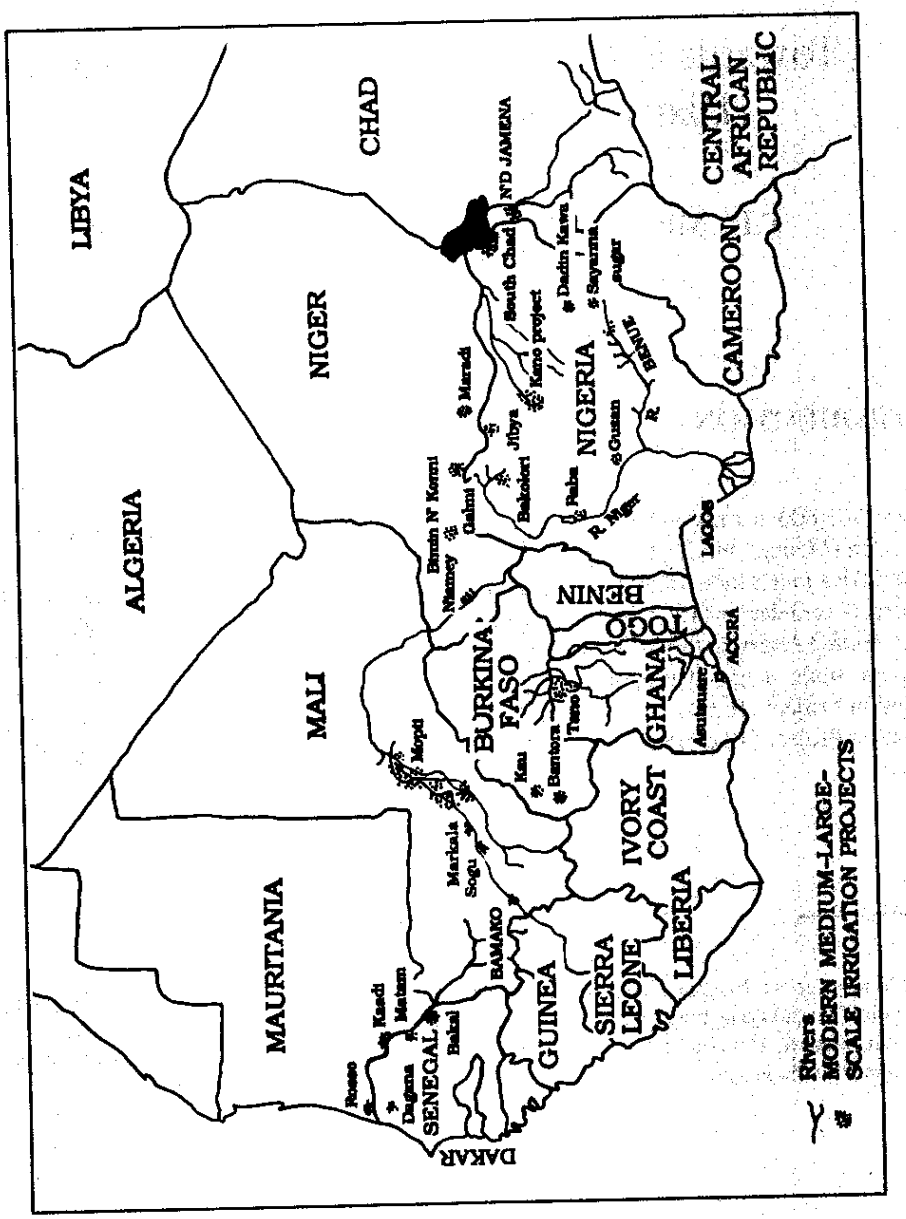
Figure 1. Map of West Africa showing modern medium- and large-scale irrigation projects.



The entire water distribution system of these projects is presently managed by the River Basin and Rural Development Authority. However, the projects are plagued by enormous problems:

1. Unrealistic assumptions about the available water supply, inaccurate estimates of crop water requirements, and losses in transit and seepage have contributed significantly to over-estimation of the area that could be irrigated so that there is a shortage of water.
2. Poor water management resulted in soil erosion and waterlogging and salinity problems with resulting low soil productivity. The changes in the environment might have also affected the health of the people and their livestock (Maurya and Sachan 1985).
3. Lack of effective farmer organizations and poor coordination between the various agencies concerned with extension and operation and maintenance of the systems have resulted in low productivity, with average yields of 1-1.5 tons per ha for the irrigated wheat crop.

Most of these problems can be solved by increasing the efficiency of the irrigation water distribution network under small landholdings and increasing participation by the farmers.

OVERVIEW OF THE LARGE-SCALE IRRIGATION PROJECTS

The three large-scale irrigation projects are in semiarid zones in the northern part of Nigeria. These projects intended to irrigate about 300,000 ha. However, only about 52,000 ha are presently under irrigation.

Kano River Irrigation Project

The Kano River Irrigation Project is one of the major irrigation schemes in Nigeria, initiated in 1970 under the Hadejia-Jamaare River Basin and Rural Development Authority. This project is the country's pioneer project, with a development potential of 62,000 ha net irrigable land. Presently, 16,600 ha of irrigated land have been developed together with a 22-kilometer (km) main canal from Tiga dam which has a three billion cubic meter water-storage capacity.

Climatic data are given in Table 1. Soils of the project area belong to the Eutric Gambisol type (FAO/UNESCO system). Soils are moderately deep, well- drained, and of a sandy loam texture at the surface with sandy clay loam subsoil. A layer of iron-pan underlies most of these soils at depths between 80 and 150 centimeters.

Table 1. Meteorological data for Kano, Bakolori, and South Chad Irrigation Projects.

Month	Air mean temp. (°C)			Rainfall (mm)			Wind speed (km/day)			Pan evaporation (mm/day)	
	K	B	SC	K	B	SC	K	B	SC	K	B
Jan	23	25	22	0	0	0	198	131	167	8.3	8.8
Feb	21	28	24	0	0	0	181	198	135	9.1	10.7
Mar	27	27	28	0	12	0	140	178	200	8.1	9.7
Apr	28	31	32	7	0	0	131	120	182	8.7	10.0
May	32	30	32	138	21	15	219	179	176	8.6	9.4
June	28	30	30	148	13	23	226	195	176	9.4	9.2
July	26	28	30	246	156	186	163	142	151	5.5	4.0
Aug	26	28	26	173	267	225	128	184	108	5.5	6.3
Sept	26	27	27	103	192	186	119	168	90	6.9	6.0
Oct	24	30	28	0	0	22	119	164	104	6.7	7.0
Nov	25	27	25	0	0	0	133	101	153	7.5	7.0
Dec	21	23	23	0	0	0	165	154	153	7.9	8.0

Notes:
K = Kano River Project
B = Bakolori Irrigation Project
SC = South Chad Irrigation Project
temp. = temperature

Source: Institute for Agricultural Research irrigation cropping-scheme report. 1975-1986.

Bakolori Irrigation Project

The Bakolori Irrigation Project was executed in 1982 with an irrigation network (including a dam reservoir with a water-storage capacity of 420,000,000 cubic meters and a 30-km main canal) and infrastructural facilities for 14,500 ha under sprinklers and 8,800 ha under surface irrigation. The main canal, fed from the dam, is divided into secondary and tertiary canals which serve irrigation units of about 20 ha each. Each unit is divided into plots approximately one-half to one hectare in area, irrigated by field ditches. The water authority usually allows each farmer to irrigate 0.4-0.5 ha in the project area. All responsibilities for irrigation and management rest with the Sokoto River Basin and Rural Development Authority. There are a few farmers' cooperatives for social, cultural, and some limited farm input supplies.

Soils in the project area are sandy to sandy loam with low available water-holding capacity and high infiltration rates.

South Chad Irrigation Project

The South Chad Irrigation Project is located within the narrow climatic band situated between the deserts of the Sahara and the region of tropical wet savanna. The area is a relatively flat clay plain bound on the north by a wide sand ridge and in the east by a natural drainage channel (Macdonald and Partners 1973). The dominant soils in the project area are vertisols that absorb water very rapidly and swell, then shrink and crack widely when dry (Siewierski et al. 1982).

The total area proposed for irrigation development is 67,000 ha under surface irrigation. However, only about 12,000 ha have been developed. Water for this project is extracted from an inland lake via a 28-km dredged intake channel leading to the primary pump station at Kirinowa. The water level in the intake channel depends on the lake water level. The main canal of 23 km starts at Kirinowa with a raised water lift pump and delivers to the branch canals (Figure 2). The smallest basin for wheat or cotton is about 0.4 ha.

The system is designed for irrigation only during the day with night storage in the distributary canals. During the period of peak demand, irrigation can be completed in 12-15 hours. Rice, wheat, cotton, and vegetables are the major crops grown in this project. Check basins for rice, wheat, and vegetables, and borders for wheat and furrows for maize and vegetables are the common irrigation methods employed.

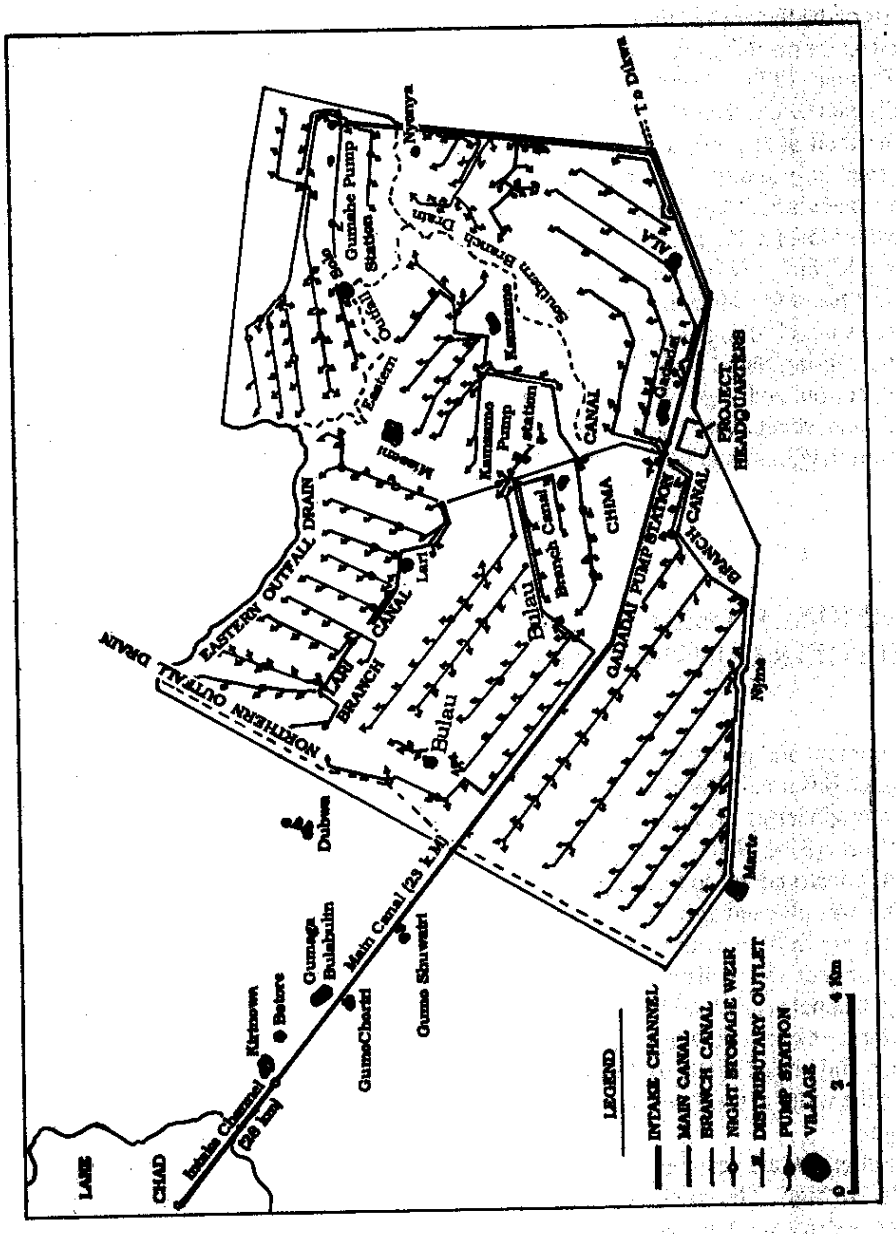
COMMONLY USED WATER-DISTRIBUTION NETWORK DESIGNS AND THEIR CONSTRAINTS

Development and management of large-scale formal irrigation schemes is the responsibility of the River Basin and Rural Development Authority. Project planning has been dominated by narrow engineering criteria and insufficient thought given to the social and economic effects of the projects (Bird 1984). In all of the large-scale projects input from the farmers regarding initial design, construction, and management has been nonexistent. The project water-distribution network was planned to be operated and managed by a highly skilled individual, forgetting that the users are farmers with small landholdings.

The project water-distribution network has been designed so that most of the field-water supply channels (blocks of 10-20 ha) end in drainage channels (Figure 2). Unfortunately, the small farmers cannot control the water released to a block so that 20-50 percent of the water at the head end goes directly to the drainage channel from the irrigation channel. However, at the tail end the water in the field channel is not enough to irrigate even half of the area it was designed to irrigate.

The channels are designed to carry less water than the capacity of the release gate. Losses due to spills are high. The combined conveyance, average application, and distribution efficiencies for border strips were as low as 26, 62, and 86 percent respectively in the Kadawa sector of the Kano River Irrigation Project where most of the conveyance systems are unlined. This gives a very low overall irrigation efficiency of about 14 percent (Adewumi et al. 1985).

Figure 2. Water distribution network of the South Chad irrigation project. (After Macdonald & Partners 1973).



In the Bakolori Irrigation Project, the water-distribution schedule was designed to irrigate fields in six-day cycles between 7 a.m. to 6 a.m. The surface-irrigation system was designed for a peak demand of one liter per second per ha in 24 hours. However, the farmers are very reluctant to irrigate their fields at night. An irrigation schedule of five-day cycles is better for their crops. The initial design of gross application of 65 mm water on a six-day cycle is insufficient for wheat cultivation in this region (Maurya and Kuzniar 1988).

The design of the water-distribution network for the South Chad irrigation project is based on a very long intake channel feeding the pump intake before the main canal. The water level in Lake Chad has receded drastically due to erratic weather in the last few years and the construction of dams upstream in neighboring countries. Hence, the long intake channel has dried up and the project is facing severe water shortages. No irrigation was possible in 1984.

The project areas have suffered from undependable and inadequate water recharge, especially in the Chad Basin project. It is believed that an unrealistic assumption of the available water resulted in overestimation of watershed yield and perhaps a change in the hydrologic system within the last two decades has contributed to the problems.

SUGGESTED IMPROVEMENTS

Although the projects were designed to be operated and managed by government-agency personnel financial cutbacks in the agency's funding have forced it to cease a number of services such as input delivery, maintenance of field channels, and operation of water distribution. As a result, the projects are near collapse.

Experiments were recently started in an action-research mode to look for ways to improve the water-distribution systems in the Kano River Irrigation Project. It was observed that the project could be handed over to the farmers for management provided the following modifications could be made in the water-distribution network of the Kano River Irrigation Project:

1. Presently, water is released to all sectors from 6 a.m. to 6 p.m., and farmers irrigate as they choose during this period every day. As a result, there are always only a few farmers in each block irrigating at the same time, and the released water is not fully utilized. About 40 percent of the water conveyed to the farms is lost to the drain unutilized. Therefore, it is suggested that water be released only to a particular sector or block on a schedule that will ensure more effective use of the water. Alternatively, the field channel or tertiary canal which serves each irrigation unit (especially at the head end of the system) should be connected at the end to the next irrigation channel (and not to the drain) so that excess water can be recaptured for use.
2. Good drainage water, especially channel runoff, should be reused. There are many areas where the drainage water can be diverted to a delivery channel downslope simply by means of an inverted siphon.
3. A water-measurement device should be installed at tertiary-canal inlets.
4. Water users' groups must be organized and trained for water management. The present study is ongoing. Several aspects of farmer-managed irrigation will be studied and a pilot project

for farmer management will be established. However, it is difficult to change the existing design of the Bakolori and South Chad Irrigation Projects where water shortage is a chronic problem. Also, the farmers in the Bakolori Irrigation Project live 5-10 km away from their fields, which makes it difficult for them to manage their irrigation.

CONCLUSIONS

The modern, large-scale surface irrigation projects in Nigeria were designed to be operated and managed by government technicians. Input and participation from the farmers were not considered during either the design or the construction of the projects. The projects are suffering from the common problems of low water-utilization efficiency and low productivity due to either faulty irrigation design or poor water management.

As a result of financial cutbacks, many government services to these irrigation projects are being curtailed and ways are being sought to have the farmers take over the operation and management of water distribution. Some improvements have been suggested for changes in the water-distribution network that will make it possible for the farmers to distribute and utilize the water more effectively. Water users' groups must be organized and the farmers trained to manage the water.

References

Adewumi, J.K., Duru, J.O. and Yadav, R.C. 1985. Irrigation efficiency at Kadawa sector of Kano River. Project paper presented at the Ninth Conference of the Nigerian Society of Agricultural Engineers, Owerri, 4-6 September 1985.

Bird, A.C. 1984. The land issue in large scale irrigation projects: Some problems from northern Nigeria. In Irrigation in Tropical Africa, Adams and Grove (eds.). Cambridge: African Study Center: 75-85.

Macdonald, M. and Partners. 1973. Investigation and feasibility study of an irrigation project south of Lake Chad. Hunting Technical Service, Ltd. publication, Vols. I & II.

Maurya, P.R. and Kuzniar, A. 1988. Needed social, cultural and design changes to successfully manage Nigerian irrigation projects. In Proceedings of Planning Now for Irrigation and Drainage in 21st Century, Delynn R. Hay (ed.), American Society of Civil Engineers: 141-148.

Maurya, P.R. and Sachan, R.S. 1984. Large and small scale irrigation systems in Nigeria -- A comparative study. In Proceedings of the African Regional Symposium on Small Holder Irrigation. Harare, Zimbabwe: University of Zimbabwe: 273-286.

Maurya, P.R. and Sachan, R.S. 1985. Irrigation scheduling in relation to salt build-up under varying groundwater table conditions. In Proceedings of the Fifth Afro-Asian Regional Conference of International Commission on Irrigation and Drainage, Townsville, Australia: 80-89.

Siewierski, E., Ojanuga, A.G. and Mayaki, W.C. 1982. Properties and management of vertisols in Ngala area Nigeria. In Proceedings of the Fourth Afro-Asian Regional Conference on Irrigation and Drainage: I:441-453.